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Invention application

Method for increasing the power dynamics of pulsed mobile radio transmission signals

1. What technical problem is intended to be solved by the invention?

Analog (and digital) control signals are required for closed-loop/open-loop control of the radio-frequency transmission power (power ramp) within transmission devices in mobile stations.

The output power of the transmission device is in this case predetermined by an analog voltage applied to the power amplifier (output stage). In order to ensure that the output power corresponds as exactly as possible to the preset value, the output power is measured, and is corrected using a closed-loop control system. The required dynamic range for the output power is, for example, up to 48 dB. The wide required dynamic range results in the following conditions:

- Crosstalk occurs in the output stage, from the input to the output. This crosstalk reduces the dynamic range and can lead to it not being possible to comply with the required drive range.

The aim of the present method is to ensure that the drive range is complied with.

- As described above, the output power is readjusted by means of an active closed-loop control system. This closed-loop control system must operate reliably over the entire dynamic range. The method proposed here is intended to extend this dynamic range.

- The value of the control signal of the power amplifier is intended to be optimized such that this control signal has to cover only a relatively small, restricted drive range.

2. How has this problem been solved in the past?

The problem had already occurred when using GMSK modulation in the GSM mobile radio system. In this case, attempts were made to comply with the required dynamic range by using complex circuitry for the power amplifier and its closed-loop control system. The problem is evident to a greater extent in the EDGE extension of the GSM mobile radio system since, in this case, both the phase information and the amplitude information must be transmitted linearly from the output stage.

3. In what way does the invention solve the stated technical problem?

3.1 What are the features of the most general form of the invention?

a) The most general form of the invention comprises a device for additional scaling of the input signal of the power amplifier in addition to gain adjustment by means of the control voltage, in order to achieve an increase in the power dynamics.

b) The general form of the invention has, according to Figure 1 in section 5, an IQ scaling unit (200) comprising at least two multipliers (240) and a table with the IQ scaling values (220) which scale the complex baseband signal in the I path and Q path.

c) A controller is used for process control for the upward and downward ramp, both for the nominal value signal for the power amplifier (251) and for the IQ scaling unit (200).

d) The scaling is actually carried out in baseband for the complex I and Q signals.

e) In addition in the general form of the invention, the controller (100) has at least one connection (103) to the power ramp controller (230), as well as a connection (102) to the IQ scaling unit (200), by means of which the blocks can be activated, deactivated and configured.

f) The general form of the invention has a power amplifier and in particular a power amplifier (400) with a closed-loop power control system (410) which receives the output power as a nominal value preset, via a control signal (251).

3.2 What features are there and what are their advantages?

The arrangement described in section 3.1 satisfies the conditions noted in section 1 and solves the stated problems, resulting in the following advantages:

a) The dynamic range of the closed-loop control system is increased by the magnitude of the attenuation of the IQ signal.

b) The isolation requirement for crosstalk from the input signal to the output signal is reduced by the magnitude of the attenuation of the IQ signal.

c) The chosen tabular values in the IQ scaling unit minimize the switching spectrum of the signal at the antenna.

d) The control signal for the power amplifier is optimized, that is to say it covers a narrower value range.

e) The previous closed-loop power control system using a nominal value preset can remain unchanged (constraint) and is still carried out exclusively in this way.

f) The invention can be used in the following mobile radio systems: GSM, EDGE (BPSK), IS136, UTRA-TDD.

3.3 What other special features does the arrangement have?

The IQ scaling unit can easily be integrated in the baseband module.

4 What is the inventive step?

The major part of the invention is the use of an IQ scaling unit comprising two multipliers (240) and the IQ scaling table (220), in conjunction with a controller (100) which scales the output voltages (244) and (245) in accordance with a predetermined function, to be precise in such a way that one or more of the conditions mentioned in section 1 is or are satisfied.

5 Exemplary embodiment of the invention

5.1 Description of the invention

Figure 1 shows an arrangement illustrating all the required elements for the most general form as well as

for the specific refinements of the invention, as well as additional blocks which are advantageous for understanding of the system.

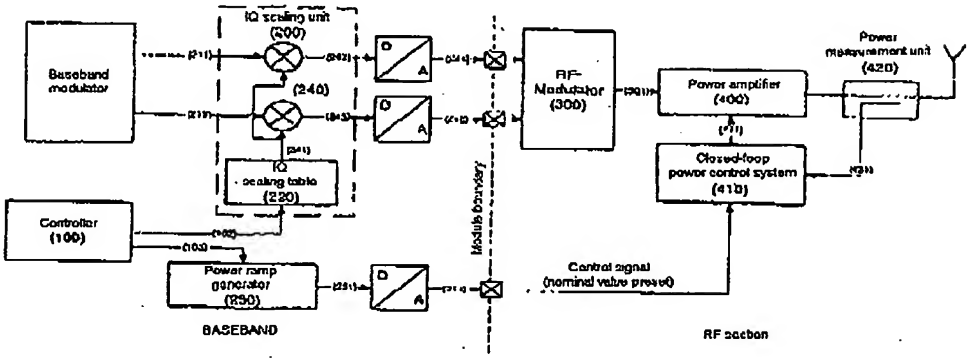

Figure 1

The arrangement of Figure 1 first of all contains a controller (100) which transmits data for the power ramps via the connection (103) to the power ramp generator (230), which itself emits the power ramp as a sequence of digital values (231). The IQ scaling table (220) is likewise driven by the controller via the connection (102), by means of whose output values (241) and the two multipliers (240) the digital I and Q signals (211) and (212) are scaled.

The scaled digital IQ values (242) and (243) are converted from digital to analog form and are supplied to the RF modulator (300) in the form of the signals (244) and (245), producing the input signal (301) for the power amplifier (400). The amplitude of this RF signal (301) corresponds to that of the scaled baseband signal, represented by the analog I and Q signals (244) and (245).

The power regulator (410), the power measurement unit (420) and the signals (421) and (411) together with the power amplifier (400) form a power control loop, which keeps the output power of the antenna constant,

corresponding to the preset value defined by the control signal (251), independently of the input signal (301) to the power amplifier.

An optimum ratio between the two input signals (301) and (411) for the power amplifier (400) can be formed by suitable time matching in the controller (100) of the IQ scaling unit and the manipulated variable for the closed-loop power control system (251).

5.2 Timing

Figure 2 shows the timing of the power control signal and the magnitude of the complex scaled baseband signal for a GSM/EDGE burst, which is illustrated by way of example:

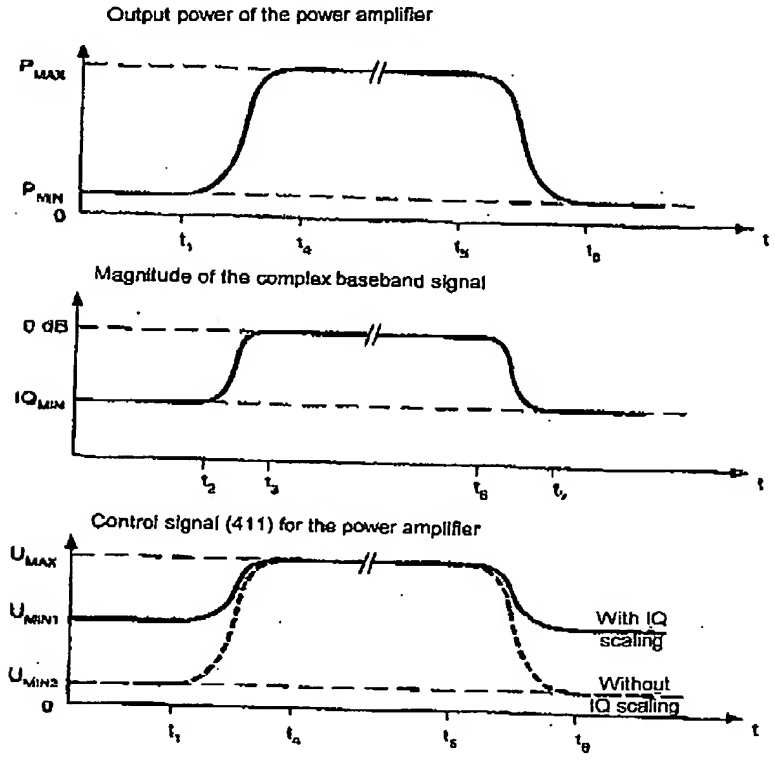

Figure 2

t_1 Activate the analog power ramp (251) for the upward ramp

t_2 Activate the digital IQ ramping (220) for the upward ramp

t_3 The IQ ramp has reached the maximum after a fixed delay time

t_4 The power ramp has reached the maximum after a fixed delay time

t_5 Activate the analog power ramp (251) for the downward ramp

t_6 Activate the digital IQ ramping (220) for the downward ramp

t_7 The IQ ramp has reached the minimum after a fixed delay time

t_8 The power ramp has reached the minimum after a fixed delay time

P_{MAX} Maximum output power of the power amplifier

P_{MIN} Minimum output power of the power amplifier

IQ_{MIN} Minimum value of the magnitude of the complex baseband signal relative to the maximum value

U_{MAX} Maximum voltage of the control signal (411) of the power amplifier

U_{MIN1} Minimum voltage of the control signal (411) for the power amplifier with IQ scaling

U_{MIN2} Minimum voltage of the control signal (411) for the power amplifier without IQ scaling

5.3 Special features of the implementation

The scaling of the IQ signal must have a continuous profile which can be differentiated over its entire profile and in particular at the start and end of the IQ ramp, in order to avoid the power amplifier closed-loop control system having to regulate abrupt changes.